DENDROCHRONOLOGICAL DATING OF THE SUPPORTING PILLARS WOODEN BRIDGES IN HISTORICAL BUKOVINA, ROMANIA

Nechita Constantin*, Popa Ionel*, Chiriloaei Francisca, Timiș-Gânsac Voichița*****

*National Institute for Research and Development in Forestry "Marin Drăcea" – INCDS, Calea Bucovinei 73 bis, 725100, Câmpulung Moldovenesc, Romania, e-mail: nechitadendro@gmail.com
**Stefan cel Mare University of Suceava, Department of Geography, 13 Universitatii St., 720229, Suceava, Romania, e-mail: francisca@usm.ro
***University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048, Oradea, Romania, e-mail: timisvoichita2004@yahoo.com

Abstract

In Bukovina, north Romania during Austro-Hungarian empire reign, were built wooden bridges representing the connection between communities. Most of the buildings were made of hardwood in the case of supporting pillars in order to offer a higher stability. The lower part of pillars remained the evidence of these buildings, because the top part was damaged in the period of the two world wars. From the wood material identified it was sampled one slice from each piece and dendrochronological analyses were performed to establish the exact period when the trees have been cut. In addition, it was evaluated the possibility that wood used in constructions could be reused since ancient times. Finally, it was established the oak wood provenience and the year when the bridge was built with an error of about 1 year, based on observations of anatomical elements of wood sap. For cross-dating were used various statistical indicators that capture with high finesse the similarity traits between dendrochronological series.

Key words: tree rings dating, dendroarchaeology, pillar

INTRODUCTION

We have sampled tree ring growth cores from 2 sets of supporting pillars of 2 wood bridges nearby Vatra Dornei area. Considering verbal information offered by locals, the constructions were built in the early twentieth century. History confirms the affirmations according to which in this area went strong fights over the period of the two world wars. Not few times these places constituted the frontlines, which is why the communication lines supported by bridges were often built then destroyed. As evidence of this fact are the presence of several rows of pillars, parallel aligned, some closed to each other with similar features. From the collected samples, we have identified oaks only on Dorna River and for this reason we have analyzed only these in the present study.

Vatra Dornei is located at about the same distance related to Suceava and Bistrița, two places from where could originate oak wood. The high interest in knowing the origin of the wood can provide an idea of social and economic issues from early twentieth century in Bukovina. The transport on long distances was done with devices hauled by horses or oxen, which

involves considerable costs and wasted time. From this reason, it was shaped the following question: what preferred the builders from that time, moving ox carts from Bistrița through Tihuța way or from Suceava through Mestecăniș?

MATERIAL AND METHOD

The study area is situated near Vatra Dornei. After sampling (DORA) the cores were processed with sanding machine to emphases the tree ring limits according to dendrochronological principles (Fig. 1). The samples were measured and statistically processed following several stages. Firstly, were cross-dated the individual series in-between two by two, in order to eliminate the measurement errors, and to establish their precise position related to the others.

The second stage it was elaborated a mean floating chronology from individual raw dendrochronological series (Towner, Creasman, 2010). Normally is that a sample/slice to contain the same number of tree rings even if they present eccentricity. In our study, related to the position of the pillar, mainly for those located in near the river channel, it can be noticed degradation of the sample. Considering that it may be missing in some places even decades, we chose to read the two radii for the position where we have identified the most tree ring (Wazny, 1992).

To date our local floating dendrochronological series, we have introduced in our analysis all available chronologies for oaks species from the neighbor regions (BISG – sessile oak near to Bistrita; TNES – pedunculate oak from Targu Neamt and CASS – pedunculate oak near Sibiu). The statistical parameters analyzed are the following: the concordance coefficient (*Glk*), the significance of concordance coefficient (*GSL*), Gleichlaeufigkeit signature (*SSG*), inter-correlation coefficient (*CC*), *t* value (t_V), Baillie-Pilcher *t* value (t_{VBP}), *t* value Hollstein (t_{VH}), (Baillie, Pilcher, 1973) cross-dating index (*CDI*) and coverage period (*OVL*). The last parameter is very important representing the common coverage of the tested series. The *t* test is conditioned by extreme years, in contrast to the Gleichlaeufigkeit parameter, for which the segments with similar slope offer the higher coefficients (Hughes et al., 1981; Hillam et al., 1987). Thus, the coefficient of concordance is conditioned by the common covering period of the series. Considering these issues, we chose as main statistical indicators for cross-dating the *t* value (Baillie, 1994; Kuniholm et al., 1996; Kuniholm et al., 2005; Billamboz, 2003).

RESULTS AND DISCUSSION

The areas from where we have collected samples are located in north Romania in Bukovina. The majority of wooded constructions from the region don't use oak woods, and in this case we suppose that the oak wood from the bridge pillars originates from nearby regions. Also, together with dating of the approximately year when the constructions were built we will answer to the questions related to wood origin. The constructions from where we have collected samples, respectively slices, are bridges over Dorna River, close to Vatra Dornei city.

Fig. 1. Image of supporting pillars from which samples/slices were collected (Original)

When wood pieces were stacked in construction they were definitely freshly cut and we can recognize that from sapwood still existing in a few tree rings. At the most pillars the sapwood is missing, and we have supposed that it was removed by the mechanic action of the hard materials transported by stream power, especially in the spring thaw periods.

Other important factor in degradation of the sapwood is related to water level modification during summer, when the water soaked wood start to dry and this process induce mechanic reactions of wood with different densities.

Firstly, were created mean series for each sample. We have performed the ”reading” of the two series on the same sample in order to reduce the

inner-stem. Finally, we arranged the mean series of each sample following the maximum level of correlation between them. Thus, it was elaborated the mean floating chronology (Fig. 2).

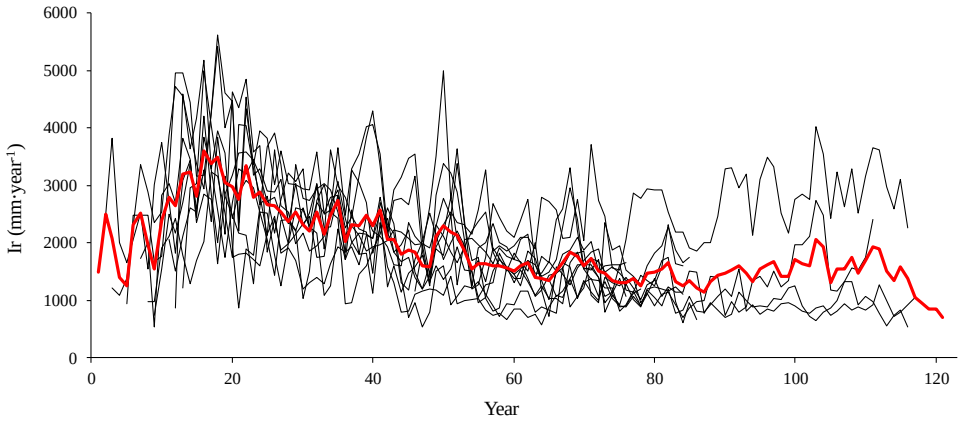

Fig. 2. Graphical representation of mean dendrochronological series for each sample (black) and mean floating chronology (red)

Mean floating chronology has a maximum length of 121 years. For a period of about 64 years the replication is represented by 9 individual series, ranging from the ring with number 45 and 109. For 105 years, the mean chronology is based on only 4 mean individual series, respectively 8 raw individual measurements. The mean tree ring width of individual series varies between 0.53 mm·an^{-1} and 5.61 mm·an^{-1} with a mean of 1.98 mm·an^{-1}. The mean radial growth of floating chronology is 1,88 mm·an^{-1} varying between the minimum value of 0,70 mm·an^{-1} and the maximum 3,60 mm·an^{-1}.

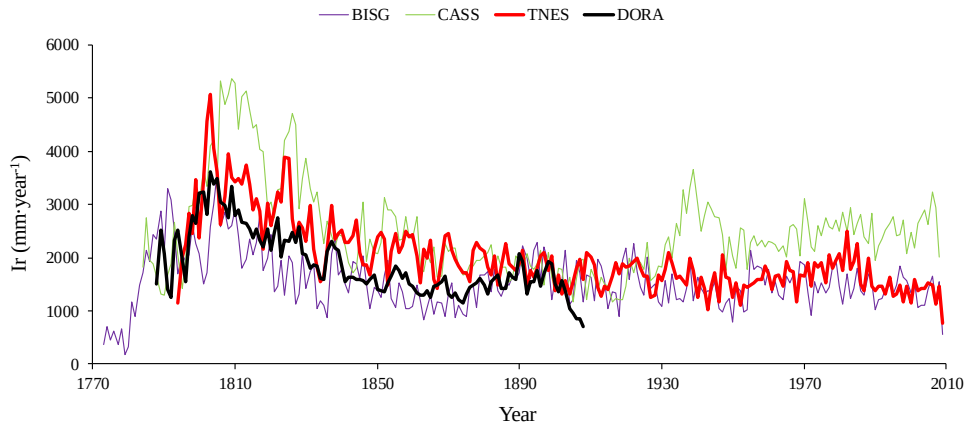

Fig. 3. Local chronology (DORA) and reference regional dendrochronological series

From the computed statistical indicators, the best-dated position of the floating chronology is in year 1908 (Fig. 3). This year was consecrated through maximum values of *t* test, offered by two regional reference series. The highest *t* coefficient was computed using oak series from Târgu Neamț, respective t=12.8. Also, for the sessile oak chronology from Bistrița was obtained a high value of *t* coefficient - t=7.3. In case of oak series from Bistrița the *t* coefficient is 5.7, inferior to the value obtained in the case of sessile oak.

For the oak series Cașolț, near Sibiu, it was obtained a high value of *t* coefficient, similar to that calculated for oak series from Târgu Neamț, respectively, t=11.9. This situation is typical for ”purely statistical matches”, respective from calculations a floating series can be positioned in at least two or three periods.

CONCLUSIONS

The fact that oak and sessile oak from Bistrița have determined values considerable different, highlight the idea that the two species can be distinguished when them are put in work. They are reacting different to the same ecological and climatic factors. The conclusion in the analyzed case is that the wood used for pillar was oak and most probable originates from Bistrița Valley, been cut the most probably around 1908.

The general conclusion which is outlined in this study is that for a more precise dating and an exactly positioning in time and space of floating dendrochronological series subjected to cross-dating processes is necessary to build local reference chronologies with a high replication and not regional. We have to take into account that it is impossible to find archaeological wood to extend in time this local series. In this case it is very important to create and extend in time the existing regional series.

To support this affirmation, we can invoke the level of *t* value combined with t_{VBP}, t_{VH}, *CDI* and *Glk* between the floating chronology subjected to dating processes (DORA) and regional chronology TNES (oak from Târgu Neamț). The correlation between residual chronology TNES and DORA series expressed by the statistic parameter *t* is superior to correlation series DORA with BISG, but is not supported by Gleichlaeufigkeit parameter which is maximum in the first case.

The obtained results highlight the importance of creating network of tree ring series, and also their utility in dating processes. Using several statistical parameters is highly recommended, but according to scientific literature it is most appropriate to accord the highest credibility to the *t* value. In dating processes, great importance has the historical context which positions at a certain time scale the floating chronology.

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